

**AFRL-SN-WP-TP-2005-115**

**VERTICAL-SENSING EFFECTIVENESS  
AND CONOPS TOOL FOR  
OPERATIONAL REQUIREMENTS  
(VECTOR) (PREPRINT)**



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**OCTOBER 2005**

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**STINFO FINAL REPORT**

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PA Case Number: AFRL/WS-05-2190, 20 Sep 05

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REPORT DOCUMENTATION PAGE					Form Approved OMB No. 0704-0188	
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1. REPORT DATE (DD-MM-YY) October 2005		2. REPORT TYPE Journal Article Preprint		3. DATES COVERED (From - To) 1/1/2004 – 1/1/2005		
4. TITLE AND SUBTITLE VERTICAL-SENSING EFFECTIVENESS AND CONOPS TOOL FOR OPERATIONAL REQUIREMENTS (VECTOR) (PREPRINT)				5a. CONTRACT NUMBER FA8650-04-D-1600-0003		
				5b. GRANT NUMBER		
				5c. PROGRAM ELEMENT NUMBER 63500F		
6. AUTHOR(S) Gary Green and James Catanzarite (General Dynamics) Denice Jacobs (AFRL/SNRW)				5d. PROJECT NUMBER 5034		
				5e. TASK NUMBER 16		
				5f. WORK UNIT NUMBER 05		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) General Dynamics 5200 Springfield Pike, Suite 200 Dayton, OH 45431				AFRL/SNRW		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Sensors Directorate Air Force Research Laboratory Air Force Materiel Command Wright-Patterson AFB, OH 45433-7320				10. SPONSORING/MONITORING AGENCY ACRONYM(S) AFRL/SNRW		
				11. SPONSORING/MONITORING AGENCY REPORT NUMBER(S) AFRL-SN-WP-TP-2005-115		
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.						
13. SUPPLEMENTARY NOTES This work has been submitted to AFRL Technology Horizons ®. If published, this publication is considered a work of the U.S. Government and is not subject to copyright in the United States.						
14. ABSTRACT Network-Centric Warfare (NCW) is the emerging concept of operations for the U.S. Armed Forces. It will allow for a decisive warfighting advantage through the increased speed of command and also the high quality shared awareness. At the core of network-centric warfare is the idea that moving away from platform-centric operations and towards network-centric operations will enable collaboration among the disparate platforms of all branches of the military that have not occurred in the past. This collaboration not only leads to a quicker and more accurately executed kill chain but also to gain decisive information superiority over an enemy before a war even begins.						
15. SUBJECT TERMS VECTOR, GIANT, TRIMSIM, Simulation, GPS, INS						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT: SAR	18. NUMBER OF PAGES 8	19a. NAME OF RESPONSIBLE PERSON (Monitor) Clyde R. Heddings 19b. TELEPHONE NUMBER (Include Area Code) (937) 255-5579 x4185	
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified				

# Vertical-sensing Effectiveness and CONOPS Tool for Operational Requirements (VECTOR)



## NETWORK-CENTRIC WARFARE

Network-Centric Warfare (NCW) is the emerging concept of operations for the U.S. Armed Forces. It will allow for a decisive warfighting advantage through the increased speed of command and also the high quality shared awareness. At the core of network-centric warfare is the idea that moving away from platform-centric operations and towards network-centric operations will enable collaboration among the disparate platforms of all branches of the military that have not occurred in the past. This collaboration not only leads to a quicker and more accurately executed kill chain but also to gain decisive information superiority over an enemy before a war even begins.

From Military Transformation: A Strategic Approach, the new rules governing warfare in the information age are: fight first for information superiority, noncontiguous operations (dispersed forces), deep sensor reach, and speed of command. Deep sensor reach and noncontiguous operations allow for time-sensitive and time-critical targets to be quickly located and eliminated. Instead of taking hours to complete the kill chain, NCW allows it to be completed in minutes. Through the sharing of not only targeting information but also hit reports, intelligence, resources, and command, a competitive advantage can be gained and the safety of our troops can be further ensured.

## VECTOR

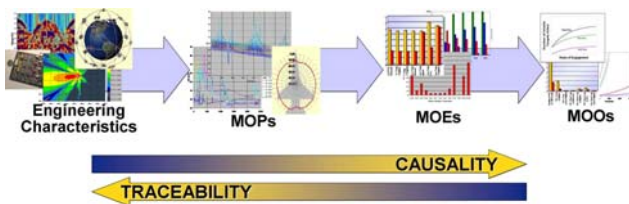
To model the information sharing concepts of Network Centric Warfare, two current software packages were interfaced: GIANT (GPS Interference And

Navigation Tool) and TRIMSIM (Theater-wide Reference Information Management Simulation). GIANT is a one versus many constructive and repeatable simulation tool used to determine navigation (GPS/INS) system performance and operational effectiveness in an electronic combat environment. A GIANT simulation consists of one platform equipped with a GPS/INS system and multiple weapons moving through a field of zero to many moving or static GPS jammers. A 24 satellite GPS constellation is modeled and Jammer-to-Signal ratios (J/S) are calculated per satellite at every point on the platform's pre-determined route. These J/S ratios are used to determine which state the GPS receiver is in on the moving platform and thus what the overall GPS position errors of the platform are. The position error of the platform has 3 components: horizontal position error, vertical position error, and time error. The position and time errors are a result of the natural INS drift of the guidance system when a platform cannot acquire or track GPS satellites. The weapon route of the munition is also modeled in GIANT. Platform errors at weapon handoff are combined with weapon miss distance and  $P_k$  curves from the Joint Munitions Effectiveness Manual (JMEM) to determine the damage done to the target.

TRIMSIM, on the other hand, is a many versus one air-to-ground targeting simulation tool which fuses errors from multiple platforms and sensors into one TLE for a given scenario. A TRIMSIM simulation consists of equipping multiple platforms with reference systems, reference system errors, and a sensors suite with the appropriate errors for each sensor and placing them at the proper range, heading, and line-of-sight to the target area. These platforms can either be static or dynamic. TRIMSIM forms a three-dimensional error ellipsoid for each platform relative to the target area and the intersection of the per platform error ellipsoids becomes the overall solution for minimized TLE. The TLE is reported from various look angles and also weapon impact angles. Along with the TLE reports, TRIMSIM also reports the major contributing input errors to the shape of the TLE. From this list, one can chart output sensitivities to input error sources.

The combination of GIANT and TRIMSIM with a third legacy software package GLACIER (Global Architecture Combat Identification Effectiveness Requirements Tool) form the backbone of a future

modeling tool named VECTOR (Vertical-sensing Effectiveness and CONOPS Tool). VECTOR is a multi-platform, air-to-ground, probabilistic tool with combat identification, data links, rules of engagement decisions, navigation and timing capability comprising a C4ISR performance and effectiveness tool. It is structured to facilitate autonomous and network-centric operations for application to single and multi-platform and sensor analyses. VECTOR will be both a constructive modeling and simulation tool as well as a tool to support a hardware-in-the-loop simulation and test facility. VECTOR will include multiple platforms and environments, combat identification, reference systems, and warfighter decision logic. VECTOR's output architecture will consist of a robust and multi-level metric collection environment which provides the capability to trace cause to effect from engineering characteristics to Measures of Outcome (MOOs).



### VECTOR Output Architecture

Each platform in VECTOR may be moving or stationary on the ground, in air, or in space. Each platform may be equipped with multiple weapons, sensors, and reference systems. Some preliminary sensors in the VECTOR architecture are: SAR, TDOA, FDOA, AOA, and EO/IR. Sensors are either active or passive and data linked both inter or intra-platform to form a network. Each platform has decision logic to determine the proper response to the threat environment.

VECTOR is also structured to support a hardware-in-the-loop test facility known as the Antenna Wavefront Simulator. This facility allows for pre-flight planning, model validation, post-flight verification, and constructive analysis. VECTOR both supports and facilitates the future of the network-centric warfare blended process.

VECTOR is designed to be an integrated system-of-systems simulation package. The software is modular and consists of "black box" modules interfaced by a data link. This architecture provides a robust way to model all types of network-centric systems from the simple to the very complex.

The VECTOR software is primarily written in FORTRAN 90/95 with some C interfaces. The simulation engine is structured and modular for easy transportation,

flexibility, and stability. Through the use of dynamic memory allocation and a rigid software coding standard, the VECTOR code will be more maintainable, changeable, and readable. The VECTOR coding standard was completed in February 2004 and has been implemented in the early development of VECTOR. Configuration management has already been established through the use of a CVS (Concurrent Versions System) server.

### CURRENT VECTOR APPLICATIONS

Over the last year, many updates to VECTOR have occurred including the addition of multiple platforms running simultaneously, multiple sensors per platform, 3-D target location error calculation, full backward compatibility with AFRL-GIANT, and a Spiral 1 software release. The Spiral 1 version of VECTOR has been applied to many studies over the past year including AFRL's SAINT Program (Synergistic, Affordable, & Integrated Navigation and Time), a Mutual Protection Jamming Study, AFRL's XTRA Program, Navy JDAM Study, and PUMAS (Persistent Unmanned Maritime Surveillance). Along with these studies, VECTOR has also been utilized to analyze emerging GPS threat environments for the future.



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